LOW-PROFILE SPRING-LOADED CONTACTS

CROSS-REFERENCES TO RELATED APPLICATIONS

This application is a nonprovisional of United States provisional patent application No. 62/215,592, filed Sep. 8, 2015, which is incorporated by reference.

BACKGROUND

The number of types of electronic devices that are commercially available has increased tremendously the past few years and the rate of introduction of new devices shows no signs of abating. Devices, such as tablet, laptop, netbook, desktop, and all-in-one computers, cell, smart, and media phones, storage devices, portable media players, navigation systems, monitors, and others, have become ubiquitous.

Power and data may be provided from one device to another over cables that may include one or more wire conductors, fiber optic cables, or other conductor. Connector inserts may be located at each end of these cables and may be inserted into connector receptacles in the communicating or power transferring devices. In other systems, contacts on the devices may come into direct contact with each other without the need for intervening cables.

In systems where contacts on two electronic devices come into direct contact with each other, it may be difficult to generate enough normal force to ensure a good electrical connection between contacts in the two devices. To provide a sufficient normal force, contacts may often have a substantial depth and consume a relatively large volume of space in the electronic device. The loss of this space may mean that the electronic device is either larger or only includes a reduced set of functionality.

These electronic devices may be manufactured in large numbers. A corresponding number of contact structures may be manufactured for use in these devices. Any simplification in the manufacturing process of these contact structures may yield tremendous savings in the manufacturing of these electronic devices.

Thus, what is needed are contact structures that are readily manufactured, where contacts in the contact structures provide a sufficient normal force while consuming a minimal amount of surface area, depth, and volume in an electronic device.

SUMMARY

Accordingly, embodiments of the present invention may provide contact structures that are readily manufactured, where contacts in the contact structures provide a sufficient normal force while consuming a minimal amount of surface area, depth, and volume in an electronic device.

An illustrative embodiment of the present invention may provide contact structures that may provide movable contacts at a surface of an electronic device. The contact structures may include a nonconductive housing supporting one, two, three, or more conductive contacts. Each contact may be located at an end of a flexible lever arm, where a remote end of the arm may be fixed to the housing. The contacts may have contacting portions that emerge from corresponding openings in the housing.

These contact structures may be manufactured in various ways. For example, the contacting portions may be attached to ends of the flexible lever arms by riveting, soldering, or the contacting portions and the flexible lever arms may be formed as a single piece. The contacting portions may be formed of the same or different materials. For example, the contacting portions may be formed of a material that provides a low resistance and low corrosion, while the flexible lever arms may be formed of a material chosen for its flexibility and its ability to withstand fatigue and cold-working. The contacting portion may have a narrowed tail extending from a wider body, where the narrowed tail may be inserted into an opening at an end of the flexible lever arm. The narrowed tail may extend through and beyond the flexible lever arm. Force may be applied to the narrowed tail causing it to expand outward, for example in a riveting process. The contacting portion may be held in place in the opening on the flexible lever arm on one side by the expanded narrowed tail and on the other side by the wider body. Each flexible lever arm may have a surface-mount contacting portion at an end remote from the contacting portion. Each flexible lever arm may further include a barb to be inserted into a notch or groove in the contact structure housing. In other embodiments of the present invention, one or more contacts, such as the center contact, may have the housing insert molded around it such that it does not require a barb. The contacts may be arranged in a line in the housing, though they may be arranged in other patterns. Contacts that are centrally located in the housing may be inserted into the housing from a bottom side and fixed in place by inserting their barbs into slots or grooves in the housing. Again, in other embodiments of the present invention these center contacts may have the housing insert molded around it. Support structures may be placed under the contacting portions of the central contacts to limit their travel such that they cannot be pushed all the way into the housing, though these may not be useful when the housing is insert molded around the center contact. Contacts located at the ends may be slid into the housing using slots in the housing. The side contacts may also be fixed in place by inserting their barbs into slots or grooves in the housing. Insulating tape may be used to electrically insulate the housing. A cover having openings for the contacting portions may be fit over the housing. The cover may have a raised portion around the openings for the contacts to fit in an opening of a device enclosure of the electronic device housing the contact structure.

Another illustrative embodiment of the present invention may provide contact structures that may provide movable contacts at a surface of an electronic device. The contact structures may include a nonconductive housing having slots for a number of conductive contacts. Each contact may include a contacting portion attached to a flexible lever arm. The flexible lever arm may attach to a contact length that may be located in a slot in the housing. A cover may fit over the housing. The cover may include a raised portion having a number of openings, each opening for a corresponding contacting portion of a contact. The openings may be located in raised portion. The raised portion may fit in an opening of a device enclosure of the electronic device housing the contact structure. The contact structure may further include a bottom plate. The bottom plate may include side tabs that fit in notches or slots in sides of the housing and cover to fix the cover and housing in place relative to the bottom plate.

Another illustrative embodiment of the present invention may provide contact structures that may provide movable contacts at a surface of an electronic device. This contact structure may include a nonconductive housing supporting one, two, three, or more conductive contacts. Each contact